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VOL. XVII JULY, 1930 No. 7

EDITORIAL

To the members of the American Electro-Platers Society: It gives me great pleasure to present to you the first issue of the Review under jurisdiction of four new officers for term 1930-1931.

It will be our great aim to equal previous work of this publication, and to surpass same as is expected of each succeeding administration if progress is to be made by our Society.

We thank all past officers for their kind assistance in trying to aid us in getting started off with speed and accuracy, and hope for the same courtesies afforded this office by the branch secretaries, officers of branches, and the patience of our members, and I can assure you the same high standard of efficiency shall be maintained by the Monthly Review.

Page 2 contains full information on new officers. Kindly note these and address all your communications to proper officers and this will promote the efficiency of these new officers and avoid usual confusion in change of officers.

The branch officers and members will also note that the Society is now incorporated under the laws of New Jersey. Also that our constitution remains the same with such changes as are legally made at conventions per provisions thereof. Also note that the 1st change is to strike out of constitution Section 3, Article XII, page 23, by majority vote of delegates.

ROCHESTER, NEW YORK NEXT CONVENTION CITY 1931

Brethren, this is a fine branch, worthy of your support, and we ask you to start now and prepare to make this the most successful convention yet.

You can reach here by land, sea or air, but committee in charge asks that none of our members try to arrive via a barrel through Niagara Falls as it will delay your arrival indefinitely and we want you there.

Rochester has a lot of fine industrial life and history, good hotels, fine park system, excellent theatres and educational institutions and exposition buildings. Everything to recommend it to the convention visitor, plenty of natural beauty spots for the lover of nature. So kindly make note of this and join A. E. S. at Rochester, N. Y.

PRIZE AWARDS, 1930—WASHINGTON, D. C.

The committee on prize awards for papers decided as follows:

Jacob Hay, Chicago Branch.....1st
C. F. Nixon, Chicago Branch.....2nd
Wm. Rowe, New York Branch.....3rd

Honorable mention: Geo. B. Hogaboom, Newark Branch, and Mr. Romanoff of Chicago Branch.

Committee on exhibit awards decided as follows:

Mr. Mac Fayden, Hart.-Conn. Valley Branch.....1st
R. E. Pettit, New York Branch.....2nd
B. M. Griffiths, Pittsburgh Branch.....3rd

Mr. Jacob Hay was decided the winner of the Founders Gold Medal by Joint Committees.

HYDROGEN PITTING AND PEALING OF NICKEL AND COPPER PLATED DEPOSITS UPON HIGH CARBON AND OTHER STEELS

By Charles H. Proctor

Hydogren pitting and pealing of the copper and nickel plated deposits upon high carbon and other steels at intervals, presents serious problems under the present intensive production of such plated products previous to chromium plating in the automotive and other allied industries.

Looking backwards thirty years or more ago when the double nickel salt solution (nickel and ammonium sulphate) was exclusively used and operated under low current densities of not more than 5 amperes per square foot of surface area, no pitting of the nickel plated finish occurred, but as I review some of the problems I met with in the late eighties, 1888 to 1890 and 1892, I now know that hydrogen was then a problem as it is today, but we did not know then its detrimental influence as it is known today.

I have talked with many of the old time platers in Connecticut, whose fathers were platers before them; men who knew the art of plating in every detail and had to produce every type of finish and in those early years there were no elaborate colored lacquers of the Duco and other types to assist in the production of contrasting effects in the production of art metal goods. The plater had to produce his own colors, principally with a so-called "French Varnish" base which consisted of grain alcohol in which was dissolved gum copal and other hard gums. Such men never mentioned hydrogen pitting or pealing of their nickel plated deposits. If such problems occurred then the problem was always laid at the door of defective cleaning or other chemical treatment of the basic steel or cast or malleable iron products, but there is no question that hydrogen has always been a disturbing factor in nickel plating operations even as it is today, but upon a more extensive and more serious basic due to intensive production from high density nickel and copper plating solutions.

Going back to the years 1888 to 1890, I was employed by the Ansonia Brass and Copper Company, Ansonia, Conn. This firm is now a part of the Anaconda Copper & Brass Corporation, who succeeded the American Brass Corporation. I then had charge

of all plating and polishing and also lacquering departments and we produced about every type of finish that it was possible to produce and this means all the antique finishes that are produced today on electric fixtures and art goods in general. We had problems then and they had to be overcome because we had to produce acceptable goods even as platers must produce today. This was in the days before volt and ampere meters, before chemical control had become a recognized factor in the operation of modern electroplating solutions, and before chemistry had become a recognized factor. Still we did produce results. How we did it is still a great problem but we carried the art along even as our fathers, who were platers, did before us.

It was in 1888-1889 when I ran into the greatest problem of all my extensive plating experience. We had to plate highly polished copper sheets some 22 inches by 54 inches in size, and 1/16 inch thick, on both sides with an adherent deposit of nickel that would not strip or peal and that would withstand temperatures of three hundred degrees F. or more beneath a hydraulic pressure of 20,000 pounds or more. Such sheets as outlined were used in the manufacture of polished celluloid in Arlington and Newark, N. J. The former plant is now controlled by the DuPont Corporation. Matt finished celluloid had to be produced as well as the polished material, so the nickel plated copper sheets had to be sand blasted after nickel plating and steam pressure was used for the purpose instead of compressed air as now used.

When we first started operations in the nickel plating of such sheets all seemed to go along well. The sheets were trimmed on the extreme ends and sides to conform with the exact size required. The sheets were then polished to a very high lustre with buff wheels with a face surface area wider than the sheets themselves. After polishing the sheets were packed with canton flannel sheets and blotting paper pads between, to avoid any possible scratching or abrasion of the sheets in transit. Such defects would always show up in the polished celluloid sheet having been transmitted from the nickel plated surface.

Later on problems developed at intervals. Nickel plated copper sheets were apparently perfect when leaving our plant. The nickel did not peal from the sheared strips when bent at right angles until crystallization occurred and the strip broken in two nor in the final polishing operation did the nickel separate from the sheets, yet

at intervals when the sheets were placed in production due to heat expansion and high pressure, the nickel would be found to separate from the base metal and adhere to the celluloid sheets when removed from the hydraulic presses.

Every operation was carefully gone over in detail when such problems occurred because it was a very costly one for my firm as they had to replace such sheets and stand for every incidental expense connected with their failure, so each shipment that failed ran into thousands of dollars.

Cleansing was thoroughly studied, removal of any oxide even of a superficial nature was carefully gone into. The current was carefully controlled under then existing conditions, but the problem still continued at intervals. We had a metallurgical laboratory in charge of my late and lamented friend, Dr. George Grower. He went deeply into the solutions and made a check-up to prove that there was nothing wrong with them but to no avail. Finally the dawn came out of the darkness and I saw the true basis of my problem; we did not know how to control it but I did in my own way. I decided to add nothing to the solution contained in a tank 24 feet long, 36 inches deep and 24 inches wide, except commercially pure ammonium sulphate and water and keep the nickel solution exclusively for plating the copper sheets.

It is strange, however, that before I discovered the probable cause of my problem, I had plated hundreds of thousands of nickel plated brass clock cases in the same solution and never had the least trouble of pealing of the nickel deposit.

We still meet with similar problems and some still think that the cleansing, or the ph. of the solution, or the current control is the cause of pitting or pealing, but I do not. If this theory was true then my firm would never have developed the extensive business for sodium perborate I first advocated for hydrogen control and 25 to 100 volume hydrogen peroxide for the same purpose of hydrogen control in nickel plating solutions.

The modern hydrogen pitting and pealing of nickel plated deposits which has caused an endless amount of trouble in the automobile and accessory industries had its origin with the introduction of the single nickel salt solution. The resultant high metal content of such solutions and high current densities carried upon the surface area which influenced hydrogen deposition or occlusion such as pitting.

When pitting first occurred with nickel pealing it was decided that heating of the concentrated nickel solution to 120 deg. Fahr. would expand the hydrogen gases or bubbles and they would rise to the surface of the solution and pass into the atmosphere, but did not solve the problem. The filtering of the nickel solution prevented mechanical pitting but not hydrogen pitting or pealing. Filtering and air agitation by compressed air did not solve nickel plating problems.

The author failed to find any true reference to any authentic work on electro-plating written during the interim between the years of 1880 and 1895 which gave any satisfactory explanation of hydrogen pitting and pealing, its true cause and cure until Dr. Madsen of Madsenell Nickel fame discovered the detrimental influence of hydrogen. Many presumed authorities who should know better in the light of present day facts still believe such problems are due to other causes, cleansing in particular or detrimental ph. or current conditions.

Dr. Oliver P. Watts of the University of Wisconsin, whom we all know and admire, in his excellent address in Pitting of Nickel Plating at the annual banquet of Chicago Branch (A. E. S.) in January, 1924, summed up the causes of nickel pitting and pealing from the reports of those members of the society who were so kind as to write to him and cite their experiences with these problems, as follows:

(a) The nickel solution too acid.
(b) It is too alkaline.
(c) Imperfections in the basic metal surface.
(d) Defective cleansing of the basic metal surface.

Dr. Watts frankly admitted at the outset of his address as follows: "Although I have used all the time that I could beg borrow or steal, I am still unable to give you a true cure for pitting and pealing of nickel deposits.

F. E. Halbert in his excellent article, "The Pitting and Pealing of Nickel Deposits," published in the Brass World in October, 1907, gave the most satisfactory explanation of the cause of such problems, but could offer no solution of the problem.

The late Emmanuel Blassett, Jr., a well known author and former member of the New York Branch (A. E. S.), wrote an excellent article in December, 1911, issue of The Metal Industry on "The Cause and Prevention of Pitted and Rough Nickel Plated

Deposits." Mr. Blassett, however, did not solve the problem in his article.

The electrical wizard, Thomas A. Edison, was the first to solve the problem of hydrogen control of nickel plated deposits. He had found the very detrimental influence of hydrogen deposition and occlusion when endeavoring to produce perfectly malleable thin sheets of nickel by electrolysis. He obtained a U. S. Patent No. 964,096 in 1910 covering the introduction of chlorine gas into the nickel solution under pressure. The function of the chlorine so injected into the solution was to combine with the excess hydrogen and from hydrochloric acid. The free acid so formed in the solution removed the excessive amounts of hydrogen that was the cause of defective malleable nickel deposits and became a factor in increased anodic reduction in the formation of nickel chloride.

The value of Edison's ideas have been amply proven during the past few years by automotive product manufacturers who have used tremendous amounts of nickel chloride which results in greater anodic reduction, greater throwing power and to a great extent hydrogen control. It was Edison's theory of the value of chlorine which gave the writer the cue several years ago to advocate the extensive use of nickel chloride. It is not a new factor, for as early as 1880 I saw it in operation in Birmingham, England, and known as "Double Nickel Chloride Solutions" for planting the old high bicycle parts made from steel and the cycle type which was then called the safety bicycle.

It has proven its value in the commercial plating industry in America and many serious cases of hydrogen pitting or pealing of the nickel deposit have been controlled by its aid. Nickel chloride sodium perborate or its product, hydrogen peroxide, are the real factors. It has proven to be true in a thousand plants during the past few years and has eliminated a great source of trouble to the plater and a costly disturbing factor in the plating industry as a whole. It is now possible to nickel plate steel in high density solutions, either still, automatic conveyor or mechanical barrel type, with nickel content as high as 12 ounces of metallic nickel per gallon of solution and obtain the very maximum results.

The problem of hydrogen pitting and pealing from the basic steel is not only confined to nickel deposits but occurs when articles made from low carbon steel such as auto radiator shells and high

carbon steels, such as used in the manufacture of automobile bumpers, etc., are copper plated. This has proven to be true in solving many problems I have met with in recent years, especially in copper plating from copper cyanide solution.

The copper cyanide solution that develops hydrogen pealing of the copper deposit may be an entirely normal one so far as metal and free cyanide is concerned and the inert factor as sodium carbonate may also be normal, still pealing problems may result even with the most careful chemical treatment of the steel articles to be plated. Such a condition developed in a large automobile plant in Toledo, Ohio, three years ago. For nearly a week the copper deposit was pealing from radiator shells when the deposit was polished to a lustre finish as a basis for the final nickel and chromium deposit. In many instances the pealing would not show up until the nickel deposit had been applied and buffed to a lustre finish, then again only when the chromium had been applied.

It was first inferred that the cleansing of the steel previous to plating was defective although the same type cleaner had previously given ideal results and no plating problems. The cleaner is a well known product of a Michigan firm, but the conclusions were that the cleaning was the true cause of the pealing problem. So the cleaner expert was called in and for nearly a week labored consistently to cleanse the product satisfactorily. I happened to be in the Ohio city where the plant is located and as usual called upon the firm which was having the trouble outlined. The matter was brought to the writer's attention and he at once diagnosed the problem as due to hydrogen and the copper cyanide solution was treated accordingly and it was also decided to treat the nickel solution for a possibility of hydrogen occlusion, although no trouble had occurred. The addition of sodium bisulphite to the copper cyanide solution up to two ounces per gallon of solution was made in proportion of one-half ounce at a time. The copper was thus reduced from the cupric to the cuprous state and the hydrogen gas, which caused the trouble, was released, due to the reaction of the *sulphurous acid the salt contained* and has never re-occurred. The cleaner expert returned during the day and when told that the problems had been overcome, stated he thought that the last addition he made to the latest cleaner installed would do the trick, but he was advised later of the true cause of the trouble.

Within the past two months friends of the author have installed in a plant in the Pittsburgh, Pa., district, a complete au-

tomatic conveyor unit for nickel, copper and nickel plating automobile bumpers. The mechanical features of this unit are perfect in united operation and capable, under forced conditions, of plating 17 carloads of automobile bumpers per day at the maximum current densities.

I was requested to write up the detailed information covering all solutions, including: alkaline cleansing, acid pickling, nickel strike, copper cyanide and final nickel deposit. The detail included the several water washings, both cold and hot, as required. The formula outlined for the plating solutions were as follows:

Nickel Solution (Strike and Regular):

Water	1 gallon
Single nickel salts	50 ounces
Nickel chloride	4 ounces
Boracic acid	2 ounces

Voltage, 6. Amperage, from 30 to 100 per square foot of surface area. Temperature, 110 to 120 deg. Fahr. Ph., 5.4-5.6.

Copper Cyanide Solution:

Water	1 gallon
Sodium cyanide 96/98%	10 ounces
Copper cyanide	8 ounces
Sodium sulphite	4 ounces
Sodium hyposulphite	1/50 ounce

Voltage, 5 to 6. Amperage, 25 to 100 per square foot of surface area. Temperature, 120 deg. Fahr.

With absolute cleansing the high carbon steel bumpers developed pitting and slight pealing in the nickel solution and hydrogen pitting and pealing of the copper deposit. Although cleaner experts and research chemists had diagnosed the pitting and pealing problems as one of exclusive defective cleansing, still the writer decided hydrogen gas was the true cause of the problem and treated them accordingly with sodium perborate, as the hydrogen controlling factor in the two nickel solutions, and with sodium bisulphite additions in the copper cyanide solution, up to two ounces per gallon. It required a minimum of one-fourth ounce of sodium perborate administered under the procedure first outlined in this paper.

If, at any time, you are confronted with similar problems first being absolutely assured that your product is chemically clean, then the factors I have outlined will solve your problems of pitting and pealing of the nickel and copper plated deposits.

As previously stated, it was Dr. Madsen who first proposed publicly the use of hydrogen peroxide as a controlling factor for hydrogen in nickel plating solutions. He advocated from 4 to 16 cc. of a 3 per cent solution per gallon of solution, or 1 to 4 cc. per litre. The active oxygen it contains and splitting off the hydrogen peroxide combined with the hydrogen as it is generated at the cathode, and thus prevents hydrogen pitting or pealing.

Hydrogen peroxide is an unstable liquid, however, which starts to decompose as soon as it is made. Moreover, it contains only 1½ per cent oxygen, the rest being water. It is, therefore, bulky and causes a great deal of expense in transportation.

It was, in order to overcome these disadvantages that I cast about to find a better source of oxygen which could be relied upon to retain its valuable oxygen until required, which would not necessitate carrying around an enormous bulk of dead matter and which would permit accurate measurement and therefore uniform results. If, besides this, such a chemical were slightly alkaline, its addition to the acid nickel solution would neutralize a part of the acid.

I found such a chemical in sodium perborate ($NaBO_3 + H_2O$) which is a powder contained 10 per cent available oxygen. Its solution in water is mildly alkaline. It can be kept indefinitely without loss of strength. One pound is the equivalent of 6.7 pounds hydrogen peroxide. It costs one-third less for the oxygen it contains. Instead of from 8.8 to 35 pounds of hydrogen peroxide per 1,000 gallons of nickel solution, we take from 1⅓ to 5 pounds of sodium perborate. The perborate should first be dissolved in warm water (100 degrees Fahr.) at the rate of 1 pound in 6 gallons. This solution is then added to the nickel bath in such quantity as experience teaches will take care of the hydrogen evolved.

In most instances the slight alkalinity of the perborate solution is of advantage in cutting down excessive acidity of the nickel bath, but when the latter is finely regulated the perborate solution may first be acidified with hydrochloric acid until it equals the acidity of the nickel bath.

I may state that in every case I have met, the perborate has acted as expected, and has prevented hydrogen pitting or pealing, which would appear to indicate that sodium perborate accomplishes all that hydrogen peroxide does, but overcomes its disadvantages and is cheaper.

INTRODUCTION OF IRON INTO ALKALINE CLEANING AND PLATING SOLUTIONS

Read at Washington, D. C., 1930, by F. J. Liscomb—Chicago Branch

How does iron get into the bath?

In what form is it held in solution?

What effect does it have on the anode?

Effect on the steel tank and steel anode rods of a silver solution?

Work is pickled in sulphuric acid—hydrochloric acid?

Neutralizing of pickling acid?

Rinse water as source of impurities in plating solutions?

Effect of ammonium chloride in nickel solution?

Effect of ammonium chloride in acid copper solution on the anode?

Effect of chlorides in a silver bath—sodium chloride—ammonium chloride—and mixture of both?

Why the addition of sal ammoniac to cyanide solutions?

Introduction of Iron Into Alkaline Cleaning and Plating Solutions

From time to time a request for credit comes through the mail for a steel plating tank that has failed, i. e., showed signs of corrosion or actually perforated. Many tanks have been replaced with new ones only to have a repeat request for another. There have been so many steel tanks that have failed that it has become a hardship for the manufacturers. As it was realized that all of the tanks could not be defective, an investigation was started in an endeavor to find out the reason for the numerous failures. One has not far to go to find this reason if he happens to be a close observer.

Steel tanks have been used for generations as containers for cleaning solutions. We used weak solutions and low temperatures and expended much arm power at the handle of a scrub brush, but all of this has been changed, and now in this age of production we must resort to less laborious methods for cleaning the work to be plated. Therefore, we install electro-cleaners and high current densities and do the work in a fraction of the time consumed by the old method of hand scrubbing.

Now, electric cleaning is a very proper method when it is performed in an intelligent manner, but unfortunately the process

has its limitations. In the first place the tank should never be made the anode of the circuit because eventually corrosion is sure to follow. Caustic soda, soda ash, or sodium cyanide, when used as a cleaner, will cause no trouble so long as there is no salt such as sodium sulphate, trisodium phosphate, sodium chloride, or ammonium chloride present; even the sulphate and phosphate may be neglected provided there is enough caustic soda present. However, if the caustic soda has become destroyed by age, the sodium sulphate and phosphate, if present, will commence to corrode the steel tank. Chlorides, no matter what kind, will attack the steel even in the presence of much free cyanide and sodium hydroxide.

If the steel tank is the anode of the electric cleaner, the plater should know if his cleaner solution is attacking his steel tank. A simple test will apprise him of the fact. All that is necessary to do is to take a drinking glass, fill up the glass with the cleaning solution (preferably filtered), then with two pieces of wire connected to the bus bars of the dynamo place a steel nail on the other ends of the wires and dip the ends of the nails into the cleaner solution. Let the electric current flow through the solution and watch the anode nail. If the solution contains chemicals that will cause corrosion, a heavy scum will form on the anode in a very few minutes.

Trouble often occurs when you have a lot of work that must be pickled. This is done in sulphuric or muriatic acid, after which you rinse, dry, polish, and go to the cleaner. The iron or steel has iron sulphate or chloride in the pores which the cleaner neutralizes. The iron in the salt is precipitated and sodium chloride or sulphate is formed. Each day increases the amount until at last the alkali is weakened and the sodium chloride and sodium sulphate get into action, and eventually, if used as an anode, the tank goes to the junk pile.

Again, we find that some operators will take the work out of the pickle and neutralize the acid in the cleaner even without a previous rinse. Neutralizing solutions have been found that actually showed acid reaction with blue litmus paper. The remedy is obvious, and it is within your power to correct the evil.

Where work must be pickled be sure to rinse the acid away by the use of several rinse waters, neutralize the remaining acid in a strong alkali other than the electric cleaner, and again rinse well, and lastly take the positive connection off of the cleaner tank and

install anode rods insulated from the tank and fitted with large, steel anodes. This last suggestion does not cure the evil; it only delays the day when the tank is junked unless care is taken to exclude the acid mentioned.

Acids are not the only offenders, for, where only one rinse tank has been installed, nickel sulphate gets into the cleaner and cyanide plating solutions in steel tanks by being carried from the foul rinse water. Nickel solutions also contain chlorides as well as sulphates, and these too should be rinsed away.

Avoid the use of low percentage sodium cyanide, as this often contains as much as 20 to 25 per cent sodium chloride. This sodium cyanide is satisfactory for heat treatment of steel but not for plating.

Just one more thought—perhaps you use what is termed the reverse current in the cleaner, and you think that because the work comes out of the cleaner with a dirty color you are plating out the dirt. Well, you are not. You are simply undoing what the polisher has done because of the fact that the cleaner is low in caustic and high in sulphates and chlorides of soda or ammonia, which means that you actually etch the work you are about to plate, and, if the "dirt which you plated out" is not removed by an acid, then the plating may peel, blister, or pit.

In the old days electroplating was something of a mystery even of the best informed. All formulae said to dissolve so much of such and such chemicals and if the solution does not work then add so and so. Then the more thoughtful ones began to investigate to try to find out the why. Finally there came methods of analysis for plating solutions. These data were based on the published methods of analysis of solutions which contained only pure chemicals—at least they did when new.

However, a plating solution that has been used for a long time may have gathered some other ingredients not mentioned in the formula, such as glue, salts of other metals such as zinc and copper, cadmium in nickel solutions, iron which may appear as ferrocyanide in alkali baths, or salts of the strong acids as chlorides and sulphates. Some of these impurities exert a powerful influence even in microscopic quantities. With this thought in mind some experiments have been carried on, not necessarily to a final conclusion but to a point that indicates that we are not going into the chemical research as far as we should, which is an argument in favor of more funds for the research committee. The results of

these experiments, as well as some observations, are here set down in the hopes that further work may be done by others more capable.

Some years ago our attention was called to a large cyanide brass plating solution which was working badly. An effort was made to analyze the solution for metals, carbonates, free cyanide, etc. As the analysis proceeded it became evident that there was a metal present other than copper and zinc. This metal proved to be iron. Since then solutions have come to hand from time to time that contained iron. However, little attention was paid to its presence; no attempt was made to ascertain in what form the iron was held or what effect it may have had on the deposit of copper, brass, or cadmium; or what, if any, action it had upon the anode. Very recently three cyanide solutions have come to hand, one a cadmium. Here it was noted that the steel supports of the cadmium anodes were gradually disintegrated to such an extent that they fell apart, and at low temperature (60° F. to 70° F.) small, transparent, sand-like crystals, which gave no reaction for either sulphates or carbonates, formed on the steel. Eventually they fell off and accumulated on the bottom of the tank. After these crystals were gathered and lay in the air for several days they lost their water of crystallization and a white powder resulted which was still soluble in water. When hydrochloric acid was added a green solution resulted. It was also noted that the tank was corroded at the ends to such an extent that it had to be replaced by a new tank.

Two copper solutions came to hand that contained a small amount of free cyanide—a little metallic copper. The solutions had a peculiar color. The anodes were coated over with a reddish-brown, fur-like coating, which much resembled copper ferrocyanide.

Experiments have been carried on with sodium cyanide solutions to which iron salts have been purposely added in the presence of varying amounts of free sodium cyanide. Both ferrous sulphate and ferric chlorides were tried. The "ous" salt seemed to be the most completely dissolved in cyanide, especially when there was sodium hydrate present. All of the iron salts, "ous" or "ic", are not completely soluble in cyanide sodium. No matter how strong or how hot the solution is there still remains some undissolved iron precipitate in the cyanide solution with either "ic" or "ous" iron in solution. When all of the iron salts have been dissolved

that will dissolve there is still free cyanide present. To these iron solutions was added enough copper cyanide so that no free sodium cyanide remained. Then, when a current of 6 to 7 amperes per square foot was passed, a good deposit formed on the cathode, while the copper anode became covered with a thick coating of a mixed, blue-green solid and a reddish-brown scum. Sodium cyanide was added in quantities of ¼ ounces per gallon until at about ½ ounces per gallon only the reddish-brown scum was apparent on the anode. At approximately ¾ ounces per gallon of sodium cyanide the anodes did not coat heavily at 6 to 7 amperes per square foot. To find what would be the effect of a greater current density with the same amount of free sodium cyanide, the current was increased to approximately 15 amperes per square foot, and it was found that in 15 minutes there formed on the anode a thick, heavy, reddish-brown coating, which corresponded to the color of copper ferrocyanide.

From this we gather that for a cold copper cyanide solution, where the sodium cyanide content must be kept down (in the interest of high cathode efficiency), the presence of iron will be detrimental to good anode corrosion due to the ferrocyanide formed. In warm solutions, where a much larger free sodium cyanide content can be maintained and we can still have a good cathode efficiency as well as a higher current density, it is predicted that there would still be some difficulty unless care were taken to offset the ferrocyanide with free cyanide, temperature, and current density.

Just how the iron gets into the solution in the first place is a problem. We know from experience that in some solutions (electric cleaning) when the work is being cleaned electrically on the anode or positive pole, the steel is attacked, showing the characteristic color changes peculiar to ferrous hydroxide; viz., the first color noticed is white. This is soon followed by a greenish color. Later this, when exposed to water or air, becomes the color of iron rust (ferric hydroxide?). Since this red color does not seem to go into sodium cyanide, at least not completely, it is presumed that when the ferrous hydroxide is white or in the early stage of the green color, and it is on the surface of the work, going into the warm cyanide plating solution, it is probably soluble in sodium cyanide, at least to some extent, and forms sodium ferrocyanide. Then, if this is so, it follows that if a piece of steel or iron is

pickled in an acid and not completely rinsed and neutralized the iron salts produced do undergo a chemical change to form hydrates (ous), which seemingly are soluble in cyanide and hydrate and do form sodium ferrocyanide.

Again, even if the iron salts from the pickle solution were not converted into ferrocyanide, there would at least be a chemical change between the acid radical of the pickle acids and the alkali of the cleaner, and there would form as a part of the reaction a sodium sulphate or sodium chloride, depending upon the acids used in the pickle (sulphate distinct from chloride). With these chemicals in the plating solutions in contact with the iron heating coils and the steel tank, which may get into the path of the electric current, i. e., become cathode near the back of the copper anode and anode at the end or bottom of the tank near the true cathode proper, at that portion of the tank that became the anode electro-chemical action is set up to such an extent that the steel tank becomes corroded and even perforated, exactly as described above in connection with certain electric cleaners. If, then, the white or green (ous) iron hydrate at the instant of formation is dissolved in the sodium cyanide and hydroxide of the bath, the final result will be the same; namely, the formation of sodium sulphate or sodium chloride and possibly sodium ferrocyanide.

Therefore, the obvious solution of the problem is to prevent mineral acids or salts of strong mineral acid from getting into the alkali plating solution even in small quantities, because, even after they have attacked the tank and at least a portion of the dissolved iron goes into solution or is precipitated as hydrate, the salt of the acid is regenerated and is free to act again, etc., ad lib. If, however, such salts are present, and they are frequently added to the solutions intentionally in the form of sodium sulphite, bisulphite, hyposulphite, sodium sulphate, ammonium chloride, etc., some provision should be made to prevent the electric current from coming into contact with the steel tank. Therefore, use rubber-lined steel tanks, which will keep down the effect of sodium sulphate or chloride on the steel tank and leave only the anodes in the solution open to the action of the chloride or sodium ferrocyanide, if present.

As it was realized that all mineral acid salts may not act the same, some tests were run which would determine which acids were the most detrimental. Then solutions of sodium cyanide with

the additions were prepared, each in a separate beaker. The electrodes were of steel and the electrodes of the several cells were electrically connected in series. A current of suitable strength was passed for a period of one hour. The presence of Rochelle salts resulted in no corrosion of the steel anode. However, in the presence of sodium chloride or ammonium chloride there was a very heavy corrosion of the steel anode; yet the action of the sodium chloride was different than that of the ammonium chloride. With ammonium chloride there the iron seemed to go into solution momentarily. As this metal-charged solution came in contact with the chemicals a precipitate formed around the drops. The color of this precipitate, at first whitish, later turned to a bluish-green color and eventually became very dark brown in spots (ferric hydroxide). As the action continued a very fine example of that chemical phenomenon known as "chemical garden" formed. As the solution filters through this precipitate or membrane to dissolve more iron at the anode, the membrane will break and the iron-bearing solution will burst forth only to be confined by a new membrane at the point of the rupture. Some of the branches were as fine as a hair and extended upward for at least two inches.

In that solution where sodium chloride was used, the action on the anode was as great as where the ammonium chloride was used, but there was no chemical garden formation.

In a silver solution made from silver chloride and cyanide, to which was added some ammonium chloride, there was still another type of result at the anode. (And from this it is gathered that there is really more in this subject than appears on the face. Notwithstanding the fact that such solutions have been used for years without complaint, it does not follow that there was no reason for complaint. Probably the thought was that these conditions just had to be, as was the case with the yellow sludge in nickel solutions where 90 per cent nickel anodes were used—"it was just there, that's all.") Both ammonium chloride and sodium chloride were present. The latter resulted from the reaction when silver chloride was dissolved in sodium cyanide. There formed at the anode a yellowish, ochre-like precipitate, which slipped off the anode and fell to the bottom of the beaker. Later, when this solution was taken out and stirred, it was noticed that the particles were very small (colloidal) and that they did not settle rapidly. The solution was then boiler with some sodium cyanide solution,

after which it was cooled and placed back in the line, and the action on a fresh steel anode was noted. On this second run the anode scale was exactly the same as in a bath where sodium chloride alone was used. Why the anode slime should change from yellow before boiling the solution to brown after boiling it is not known, unless the boiling drove off the ammonia to form additional sodium chloride.

It begins to look as if there are certain plating solutions in which ammonium chloride may be used, while in other solutions it may be useful; as for instance in nickel solutions where the ammonia complex seems to cause an action on the anode whereby the anode efficiency is greater than the cathode efficiency. At least the metal content of the solution does increase. However, in an acid copper solution ammonium chloride will cause a yellow copper chloride to form on the anode which is insoluble in the acid copper solution. This may be gathered and washed and dissolved in nitric acid, and with silver nitrate test solution it will react for chlorine. Again, with the presence of sodium chloride in certain types of nickel solutions where high current densities are used, it has been noticed that the sludge is rich in nickel hydrate which forms and settles at the bottom of the tank.

Later Experiments

It was noticed that in a solution known to contain ferrocyanide, sal ammoniac, and sodium cyanide, and in a silver solution which contained both sal ammoniac, sodium chloride, and sodium cyanide, the iron anode scum was of a dark blue color upon being examined in a strong light when dry (see above). When it was treated with ammonium chloride a portion of it went into solution (Prussian blue).

With ammonium chloride and cyanide and an electric current a yellow scum formed on the steel anode (see remarks above on silver). Hot caustic soda dissolved a portion of this precipitate. The solution then gave a green color with hydrochloric acid (iron). When a copper anode was put into action in this solution it gradually became covered with a red copper ferrocyanide, indicating that the iron that had been removed from the steel anode due to the presence of the ammonium chloride had been dissolved in the cyanide; or else this was done by some reaction that did cause the formation of sodium ferrocyanide. This, of course, set free the chlorine, which was then free to attack the steel tank or other

iron that got in the path of the electric current. (Series.)

In the solutions of ferrocyanide, sodium cyanide, and sodium chloride, the anode scum seemed to be wholly red iron hydroxide.

In a solution of sodium cyanide and sal ammoniac the copper anode gives off a green color which is expelled by more cyanide, but when the sodium cyanide becomes saturated the color of the solution and the slime from the anode indicate the ammonia copper complex and the presence of ferrocyanide, as the copper anode takes on a red color.

When only sodium cyanide is run with a steel anode there is no visible action on the steel.

Summary

Work which is pickled in hydrochloric acid, or other acid for that matter, should be well neutralized and rinsed several times in clean water before going to a plating solution.

Cleaning and alkali plating solutions should be free from all chloridets, or

The tanks should be rubber lined.

Unlined steel tanks should not be used as the positive or anode in any cleaning or plating solution.

All electric cleaning and alkali plating solutions should be tested with steel electrodes to see if the solution attacks the steel tank under the influence of the electric current.

Seemingly sodium ferrocyanide does not interfere with anode corrosion in alkali copper solutions except where the free cyanide content is low and the current density is high.

Sodium ferrocyanide in the presence of sodium cyanide does not effect the steel anode seriously.

Rochelle salts added to cyanide solution did not attack steel, but 76 per cent sodium cyanide, i. e., chloride mixture, should not be used for plating.

Ammonium chloride should not be used in acid copper solutions.

Steel tanks should be rubber lined to prevent a metal deposit on the tank back of the anode, i. e., false cathode. At some other point as the end or bottom of the tank, i. e., false anode, if chlorides are present in the solution the tank may be expected to be corroded or even perforated due to this series connection. Moral—Line steel tanks.

The object of this paper is not to tell you something but rather to start something.

Thanks are due to Dr. W. Blum and also to Mr. Harold Faint for helpful hints.

CADMIUM PLATING

Read at Detroit 1929 Annual by H. C. Pierce

This morning you heard a specific talk on cadmium plating. This goes in the other direction, and is entirely a general discussion on cadmium.

The corrosion of metals and its prevention is daily receiving more and more notice, and is today one of our major engineering problems. The numerous works and publications of recent years show the activity of the investigators in this field; a field of paramount importance, but one of the most complicated and least known in all chemistry.

The goal of the investigator in corrosion has been to thoroughly grasp the fundamental laws of corrosion, which, however, has been very difficult, as the possibilities of corrosion of industrial products are almost unlimited. It can only be predicted to what influences a material will be subjected, so that all precautionary methods of protection are more or less one sided. The progress made in this field shows that the engineer is not as helpless in combating corrosion as in former times. Ways and means can and will be found to combat this resistless attack.

An accurate estimate of the loss resulting from corrosion of the metals in common use is quite impossible. This yearly loss is known to amount to millions of dollars. Much of this loss is invisible to the casual observed, but it is only necessary to observe a few of our junk yards to have this fact forcibly brought to mind. Some part of the corroded metal is recovered as scrap, but the cost of replacing such parts far exceeds this saving. Rusting and corrosion may also impair the strength of structures and machines, thus endangering not only property, but human lives.

Aside from the actual destruction of parts, and cost of replacement, there is still another factor of extreme importance. Roughly, the loss and replacement of 1,000 tons of steel gives a depletion to our national resources equivalent to 2,000 tons of ore, 4,000

tons of coal, 500 tons of limestone, together with magnesite, chromite, etc. The labor required also involves a large number of man hours.

The more numerous the uses of a product, the more are the kinds of corrosive attacks to which it is subjected. The best example is that of iron and its alloys, which are used in all branches of industry and technology. The widespread use of iron has been the means of bringing forth almost countless methods for protecting iron from corrosive attacks. The method of protecting the surface depends primarily on the use to which the article will be subjected. Of the various methods used in protecting metal surfaces, metal coatings and methods of their application play a particularly important part. Various metals have been successfully used as metal coatings on other metals. Gold, silver, lead, tin, nickel, copper, brass, chromium, zinc and cadmium have all been used in an attempt to stop or to retard the resistless advance of corrosion. Each metal has its own specific properties, so that each metal has its own particular field of usefulness in this relentless battle against corrosion. Likewise, these same specific properties often limit the value of a metal as a rustproofing agent.

One metal, however, has been found to be of particular value in protecting ferrous metals against corrosion under a maximum of conditions. This metal is cadmium. Cadmium was discovered by the German Chemist Stromeyer in 1817, while investigating the peculiar yellow color of a zinc oxide. Although discovered in 1817, it is a comparatively new metal industrially. Most metals, especially those found of value in the plating industry, occur naturally in ores and are more or less easily obtained. Metallic cadmium does not occur naturally, and there is no ore of cadmium or mineral of which cadmium is the main constituent. Only certain compounds of cadmium, mainly carbonates and sulphides—are found associated in minute quantities with the ores of zinc, and in still lesser quantities with the ores of lead and copper. Actually, the presence of cadmium in lead and copper ores is due solely to the presence in them of zinc compounds or minerals, in the absence of which, the ores would be cadmium free.

The ratio of cadmium to zinc varies greatly, and is often too small to be of any value whatever. The useful ratio varies roughly from 1 to 160 to 1 to 400, the latter ratio probably being nearer the average than the former. The production of cadmium except

as a by-product is of course unprofitable, so its extraction is always associated with the metallurgy of the ore in which cadmium occurs.

Even though cadmium is obtained only as a by-product, the purity of commercial cadmium is extremely high, it usually containing less than 0.5% of foreign matter, and usually approaches 99.9% purity. The impurities usually found are traces of zinc, iron, lead, tin, copper, nickel, and very occasionally, traces of thallium.

The production of metallic cadmium has increased more than ten fold in the last ten years. In 1919, approximately 100,000 pounds of metallic cadmium were produced in the United States, while in 1927, 1,074,654 pounds of metallic cadmium were produced. Figures for 1928 have not been obtained, but undoubtedly exceed those of 1927.

The use of cadmium for electro-deposition has increased even more rapidly. In 1922, with a cadmium production of approximately 131,000 pounds, most of which was used in the manufacture of paints, chemicals, solders, etc., only a few hundred pounds were used for electroplating purposes. From that time on, the increase was rapid. In 1928, the Udylite Process Company alone used approximately 650,000 pounds. In the first four months of 1929 the Udylite Process Company actually sold and delivered to Udylite licensees 329,000 pounds of cadmium metal. This means that during 1929 one company alone will handle approximately 1,000,000 pounds of cadmium metal for electroplating purposes exclusively.

When it is considered that the average coating is only 0.0002" thick, the volume of work covered assumes staggering proportions. This amount of cadmium metal if spread on the earth's surface to a thickness of 0.0002", would cover an area of approximately 4 square miles, or 2,500 acres.

The color of cadmium metal itself is very often referred to as tin color, but it may be described as having a silver white color with a blueish tinge, and is more nearly the color of steel than of tin, which possesses a yellowish cast. Cadmium has a brilliant luster when freshly cut or polished, but becomes dull when exposed to the air. Cadmium crystallizes in hexagonal pyramids. The metal shows no cleavage, the fracture is brilliant and crystalline when pure, but fine grained and dull when impure. Pure cadmium sticks, when bent, give a sound very familiar to the so-called "tin

cry." Impure cadmium sticks do not give this cry when bent, so in an emergency this test may be used as a rough test of purity.

Cadmium is soluble in most acids. Strong alkalies, such as caustic soda or caustic potash, which dissolve zinc very rapidly, have little or no action on cadmium. Cadmium combines directly with chlorine, bromine and iodine when placed in solutions of those elements. Cadmium is also soluble in ammonium nitrate.

Cadmium is harder than tin and softer than zinc. It is malleable and ductile at ordinary temperatures. Being soft, cadmium will not resist heavy mechanical wear, nor the action of abrasives. On the other hand, its softness and ductility make it more resistant than zinc or nickel to knocks or blows, just as a tough elastic enamel will outlast a brittle enamel.

The electro-deposition of cadmium has developed almost entirely in the last ten years. Acid and ammonicial solutions have been proposed at various times, but such solutions were found to be quite unstable, changing in composition quite rapidly, and producing a crystalline or porous deposit. This latter evil could only be partially remedied by the use of addition agents of various sorts. Cyanide solutions, even without addition agents, produce finely crystalline, though dull depostis, while various well known addition agents not only reduce the crystalline size still further, but impart a lustrous color very pleasing to the eye. Cyanide solutions are relatively stable as compared to acid or ammonicial solutions, requiring a minimum of care under severe conditions. As a consequence, cyanide solutions are mainly used for the electrodeposition of cadmium.

A metallic coating may protect the ferrous base either chemically or mechanically or both. Cadmium protects both chemically and mechanically. To protect the ferrous basic metal chemically, the coating metal must stand above iron in the electromotive series, so that in case the underlying metal is exposed, and moisture is present, which is almost invariably the case, the coating metal will function as anode in the little galvanic battery so formed, and corrode in preference to the basic metal. Some difficulty has been found in placing cadmium accurately relative to iron. Apparently, in the presence of moisture and corrosive substances, the easily changing iron potential and the overvoltage of hydrogen on iron, play a decided role. Regardless of the difficulty of definitely establishing the position of cadmium, practical experience has shown

that cadmium undoubtedly stands above iron, and that it is now the best rustproofing agent, bar none.

Cadmium also protects mechanically. Even though cadmium is electronegative to iron, and porosity does not mean immediate rusting of the underlying iron, it is essential that the plate be as free as possible from porosity, in order that maximum benefit be derived from its properties. The ideal plate must also have perfect adherency, be free of blisters and irregularities, be ductile, dense and preferably bright in color. Cadmium deposits with such characteristics are obtained from most of the cadmium solutions in use today.

Efficient results in cadmium plating, as in other types of plating, depend essentially on three factors—the proper type of solution and means of controlling this solution, proper electrical conditions, and proper handling of work. Under this latter may be included cleaning, pickling, rinsing before and after plating, handling, storage, etc.

The majority of solutions used today for the electrodeposition of cadmium produce deposits of finest crystalline structure and a minimum of porosity, as well as maintaining a constant composition under a maximum of varied operating conditions. Even with an ideal solution, work may often be spoiled by bad electrical connections. All leads should be of sufficient size to carry the necessary current, and all connections and contracts should be clean and tight. A source of trouble which is often overlooked are the contacts which the anode hooks make. All other connections are made by means of clamps or bolts. Here, however, contact is nearly always made by mere suspension, so that even under ideal conditions, there is possibility of electrical loss here. Corrosion products often form under the anode hooks, thus increasing the electrical losses still further. Even with proper leads and connections all the way from the generator to the solution, there is a final point often overlooked. Wires and racks for hanging work must be of a size to carry the necessary current. Obviously, a part which requires 30 amperes for proper plating, should not be suspended on a wire with a carrying capacity of only 15-20 amperes. This, however, is often done.

Even after work has been hung in the plating bath, it may be spoiled by improper amperage, or current distribution. In the matter of current distribution, best results are naturally obtained

with only one piece in the tank at a time. In production, however, the tank must be loaded, and often loaded with pieces of varied size. Current is free to pass through various channels, and the amount that does pass through a given piece is a function of the size of the piece; contacts to anode and cathode, size of racks or wires; distance away from anode; the solution itself, and finally the voltage impressed. Each time the tank is loaded, the chief variables are the number, size and shape of the pieces, and the contacts. The operator should see to it that each piece is gassing as evenly as possible, that the contacts do not become hot, and that the plate is as evenly deposited as possible. Sharp edges always receive the most current, consequently they will brighten first. If the edges are dark, the work is burned, which indicates too much current. It is best to strike a happy medium between high and low current density.

Poor cleaning is responsible for a multitude of plating ills. It is readily recognized and accepted, but it is very difficult to remedy in many cases. Since the cleaning problem is usually an individual problem, and so many excellent articles have been written on cleaning and pickling, which later may be considered a branch of cleaning, that I will not go deeply into this subject. I will merely state, that even though it is sometimes possible to obtain a good cadmium deposit on dirty looking work, consistently efficient results can only be obtained by perfect cleanliness at every step in the plating department.

After the work has been cadmium plated, it should be immediately rinsed in cold water and then in hot water at approximately boiling temperature. The water should be clean to prevent staining. Where facilities permit, small parts may be dried in a centrifugal, which eliminates water staining.

The plated work should be removed as soon as possible from the acid fumes and steam atmosphere of the plating room; it should be stored in clean boxes, handled by clean hands and placed upon clean work benches.

In this paper, I have endeavored to show very briefly the necessity for such a metal as cadmium, its origin, its development and rise to a most commanding position in the electro-plating world, and finally a brief and general discussion of the best plating room practice to insure successful cadmium plating.

A REPORT OF THE POSSIBILITIES OF POISONING FROM CADMIUM PLATE

Read at Detroit 1929 Meeting by George Dubpernell

The question of the possibilities of poisoning from cadmium plate frequently comes up, but the published information on this subject is very scarce. The possibilities are often vastly overestimated, there being no definite evidence available to the contrary. Under these circumstances it would appear advisable to discuss the possibilities in detail, in order to define them.

There appear to be no cases on record of persons having died from cadmium poisoning due to cadmium plate or cadmium salts. An authoritative text book on "Toxicology" states that, "So far as one may find, no deaths have been reported from employment of cadmium salts and in man the acute effects are those of a gastro-intestinal irritant."

A British engineer is said (Chemical Trade Journal, Volume 75, pages 3 to 5, 1924) to have died from the effects of cadmium vapor which he inhaled when some cadmium was melted and overheated in an open crucible, instead of in the regular furnace, which was out of order at the time, There is no danger of this kind in the use of cadmium plated products, as the quantity of cadmium on them is so small.

Only one article appears to have been published on the use of cadmium as a coating metal for food containers, and that is German (Zeit, fur Unters. der Lebensmittol, Volume 54, pages 392-6, May, 1927). Lead and zinc are prohibited in contact with foods in Germany, and this article is mainly a plea for the inclusion of cadmium in the lead-zinc law.

Here in the United States, the Bureau of Animal Industry of the Department of Agriculture has prohibited the use of both zinc and cadmium in direct contact with meat or meat food products for considerable periods of time. This does not mean the complete prohibition of cadmium or zinc plating in the packing houses, however, and it is of course permissible to protect various parts of mechanical equipment, etc., from rusting in this manner, as long as they do not come into direct contact with meat or meat food products for a long time.

Cadmium salts are not accurately described as poisons to the human system from the ordinary person's point of view. In some cases they have been prescribed by physicians for use as an emetic. The government chemists have shown that cadmium salts are 8 to 9 times as effective as zinc salts when used as an emetic. The same men, and also many other workers, have found no cumulative effects of cadmium salts when fed to animals for long periods of time. (Journal of Pharm. and Exp. Therap., Volume 21, pages 1-22, 59-64, 1923, and Journal Pharmacol. Proc., Volume 13, pages 504-5, 1919.) That is quite different from the case of lead salts. If you get just a trace of lead, it continually stays in your system and eventually it becomes badly poisoned by it, if you keep on getting a small quantity of lead.

The effect of cadmium salts when taken internally is to cause severe vomiting, diarrhea, nausea, headaches, etc., and temporary local injury to certain organs. The most severe case on record was described by G. A. Wheeler in Boston Med. & Surg. J., Vol. 95, P. 434-6, 1876, in which several women took from .25 to 1 grams of cadmium bromide, each, accidentally; both were made violently ill; one recovered in about 24 hours and the other in about 5 days.

Cadmium salts have valuable antiseptic and bactericidal properties and have been recommended for various therapeutic uses.

Cadmium is only very slightly soluble in neutral or alkaline solutions, and in solutions of organic substances in general. It is, however, slightly soluble in weakly acid solutions, which sometimes occur in connection with foodstuffs. Zinc, on the contrary, is soluble in both acid and alkaline media and generally at a greater rate owing to its higher solution pressure. The difference between zinc and cadmium salts considered as poisons is one of degree only, the cadmium salts being stronger in their action.

Cadmium metal is fairly rapidly attacked by any foodstuffs of an acid character, such as vinegar, hard cider, fruit acids, etc. Fresh meat, blood, milk, etc., have practically no action upon metallic cadmium when they are fresh and edible, because they are slightly alkaline in reaction. However, when these protein containing foodstuffs decompose or turn sour, they generate acids or amino compounds which may have an action on cadmium, and when the cadmium is then dissolved, it causes sickness for a few hours or a day if sufficient quantities are ingested into the human

system. We have actually encountered at least several such cases of sickness caused by cadmium getting into foodstuffs; the results in these cases were rather unpleasant, and painful internal disturbances, frequent vomiting, etc., occurred.

The situation can probably be summarized as follows: Cadmium in its dissolved state is a powerful emetic and its general use in contact with foods is to be avoided. It is only possible to use it in specific cases where the conditions are definitely known and do not vary, where the foodstuffs in question is neutral or alkaline in reaction, and will not turn acid.

Acid food products such as vinegar, lemon juice, and other fruit juices, sour milk, etc., may attack cadmium plate quite readily and cause illness to persons who eat the foodstuffs.

CHAIRMAN VAN DERAU: Have any of you any questions to ask of Mr. Dubpernell?

MR. JOHN E. STERLING: I would like to ask Mr. Dubpernell a question. In the event of knives cutting into salt meat, and so forth, you think the cadmium plate would be affected?

MR. DUBPERNELL: No, I certainly don't. That was where this question first came up, in the packing houses. I have here some shroud pins that were tested for use. (Shows pins.) These had been immersed in fresh meat over night while it was cooled. You see, they kill the animal and then pin a shroud on it with these pins. They are put in the meat when the meat is warm and fresh, and then the meat is cooled in the refrigerator over night. These were immersed eight times, eight over night periods, and the cadmium is still on them. If you were going to get any injurious action, the cadmium certainly would have been taken off in that length of time. Experience has shown that they can use these shroud pins, put them in meat over night for—I don't know, they don't know themselves, but they have told me as much as one hundred times before the cadmium is appreciably attacked. Possibly at the end of that time it has been worn off by pushing in and pulling out.

MR. STERLING: How would that apply to salt and pickled or brined meats?

MR. DUBPERNELL: I imagine it would be all right in that case, too. But you have to be careful; you can't go too far. Fresh products are all right. It is something salty and neutral or alkaline in reaction. But the minute you get anything that may

turn acid, for example, if you don't wash these things off and leave particles of meat on them, as the meat decomposes it will corrode the cadmium. If you keep using it in fresh products it is perfectly all right.

EDUCATION OF ELECTRO-PLATERS

Remarks on the Class Held by Chicago Branch, A. E. S., in 1930

At the February, 1930, meeting of Chicago Branch, American Electro-Platers Society, a committee of five members was appointed to investigate the best way to hold a class in "The Analysis of Plating Solutions" and report its findings at the March meeting. The report led to the immediate establishment of such a class which in two months covered the analysis of the following solutions for specific constituents as indicated:

Acid Copper Bath—
- Free Sulfuric Acid
- Copper Sulfate

Cyanide Copper Bath—
- "Free" Cyanide
- Copper Cyanide
- Sodium Carbonate

Brass Bath—
- "Free" Cyanide
- Sodium Carbonate
- Zinc Cyanide
- Copper Cyanide

Nickel Bath—
- Nickel Content as Metal
- Acidity or Alkalinity of Methyl Red
- Chloride Content

Chromium Bath—
- Chromic Acid
- Sulfuric Acid

Additional instruction sheets were given for both acid and alkaline zinc baths, cadmium baths, and silver baths.

At our May meeting we held a pleasant graduation exercise to award certificates to the 43 men who earnestly struggled through

the complexities of chemical analyses, that they might be able to control their plating baths in a scientific way and eliminate the guess-work that occurs when even long experience finds trouble not just like anything previously met and conquered.

And now to follow specifically the outline suggested by Dr. Blum for a basis of comparison of work done in various Branches, the report will show as follows:

1. "Number of classes per season."

One—in Analysis of Plating Solutions. Possibly two next year.

2. "The frequentcy of meetings."

Two evenings a week, from 7 to 9, for 8 weeks.

3. "Fees charged for instruction and equipment."

Sufficient to defray such expenses of the class as were necessary, by assessment.

4. "The subjects covered in the courses."

Only one this season—The Analysis of Plating Solutions.

5. "The method of instruction."

Laboratory work based on mimeographed instruction sheets, supplemented by constant supervision of instructors.

6. "The attendance and interest of the platers."

Class of 43 platers, ages 28 to 61 years, averaging 43 years, with an average attendance of 40 men.

It is the writer's belief that success in classes requires certain definite procedure.

1. Actual laboratory work by every man or not over 3 men to a unit.

2. Not to exceed 2 evenings a week during cool weather.

3. Short 6 to 10 week courses, covering definite topics with practical applications.

If any attempt is made to cover the field of electro-chemistry, the writer believes trouble is ahead—for many of our best platers lack the background of education necessary to a course highly theoretical and do not have the time nor energy after a hard day's work to undertake the task of mastering a high-brow, high-pressure, highly theoretical course which is necessary to a full "chemical understanding" of a practical production process.

HAROLD W. FAINT,
Chicago Branch, American Electro-Platers Society.

Read at Annual Convention, Washington, D. C., July 1, 1930.

DEPARTMENT OF COMMERCE BUREAU OF STANDARDS, WASHINGTON, D. C.

Appointment of Research Associate American Electroplaters' Society

At a meeting of the Research Committee in Washington on June 30th, it was decided that the present funds warrant the appointment of a Research Associate for a period of one year, with a reasonable certainty that sufficient additional funds will be collected during the coming year to continue his services. The specific subject to be studied by him at the Bureau of Standards is the protective value of plated coatings, especially of chromium.

For this position the Committee feels that the following qualifications are desirable:

1—Graduation from a course in chemistry or chemical engineering in a college of recognized standing.

2—A few years' experience, preferably in research or development work in electrochemistry or electrodeposition.

3—Ability to present the results of research clearly and forcibly to those interested.

The salary to be paid will depend upon the qualifications of the person selected, and is likely to be between $2400 and $3600 per year, with a reasonable rate of promotion.

Any person who desires to be considered for this position is requested to send an application to Dr. William Blum, Bureau of Standards, Washington, D. C. This should include his name, age, address, education and experience, the minimum salary he will accept, and the names of former teachers or employers who are familiar with his qualifications. All applications will then be considered by the Research Committee.

A. E. S. PAGE

Assembled Expert Scraps With and Without Significance

It looks like our capitol has at last gone dry.

Did you notice R. J. Hazucha and J. Oberender doing a lot of taxi riding Sunday evening? Rudy says there was no beer and John agrees.

The Platers looked so tarnaly sober many were taken for Senators in the corridors of the hotel.

H. Flanagan sure forgot his knickers, and we missed his good wife. Also Mrs. Tom Haddow, even if Tom don't play with knickers.

A. P. Munning, Capt. Taylor, Van Winkle Todd, Archie MacDermid and Sam Huenerfauth were there. Did you see them spreading the stuff that makes good around the lobby.

Our good friend, Dr. De Baun, was there as usual and we're glad he was.

Balti.-Wash. Branch members did themselves proud and we all thank them.

Dr. Blum sure did not get much sleep during the annual meeting and his good wife gave freely of her good offices.

Our past editor sure ought to be able to watch around now after that wonderful testimonial of friendship.

Horace, Phil and Oliver, three must get theres. "Yes."

Did you notice those Slattery's, John, Tom and the missus, all busy?

Oh boy! Did you notice the way the gang ate those box lunches at the Navy Yard?

Some thought that visit to the Tomb of the Unknown Soldier and depositing our respects in form of wreath by Boy Scout R. Mesle.
offices also.

Did you see Ed Musick and Geo. Laurence at the desk? Horses. Yea.

Where was E. Lamoureux H. H. Williams and Ed Willmore?

PRESIDENT'S LETTER

Well, members, we just completed another epoch in the history of our society in the convention held at Washington, D. C., and also elected a new set of officers who will try and continue the progress of this society and its ideals and as your president I hope that I can count upon your continued interest and zeal in helping me to do this.

Your past editor, F. J. Hanlon, at this convention coined a new meaning for the abbreviation of our name, A. E. S., in his reply to presentation of the society to him for his work as editor for past four years. He stated that A stood for animate, E for energy and S for sincerity, and defined these from Webster's interpretation as follows: Our membership is full of spirit, keen and enthusiastic, with freedom from hypocrisy and pretense, and such being true we can feel assured that 1930-1931 will be a year of progress with our ideals much advanced.

GEO. GEHLING, President.

TO MEMBERS OF A. E. S.

I would be remiss in my duty to you if I did not at this time thank you one and all for the kind expression of friendship tendered to me at Washington, D. C., annual meeting. Also Mr. George B. Hogaboom for his kindly interest in the matter, and I hope it will direct my memory to the many good times I had while serving you and cause a watchful interest in the future of our society, and in turn I wish that all the members of A. E. S. will remember that the wisdom it has been my pleasure to obtain through the experiences while serving you shall always be yours for the asking.

Respectfully yours,

F. J. HANLON, Past Editor.

AMERICAN ELECTRO-PLATERS SOCIETY

Secretary-Treasurer's Yearly Membership and Financial For the Fiscal Year Ending May 31, 1930

TOTAL EXPENDITURES

Printing and Mailing "Monthly Review"	$2,361.78	
Printing Supplies for the Branches	108.84	
Detroit Convention Expenses (Reporting mailing letters and reports)	733.79	
President's office expenses	19.00	
Editor's office expenses	45.35	
Sect.-Treas. office expenses	85.57	
Officers' Salaries	250.00	
Officers' Mileage	397.60	
Secretary's Bond	2.50	
Founders' Gold Medal	42.00	
Research Committee, mailing reports	94.58	
Constitution Committee	6.00	
Sundries	5.25	
	$4,152.26	
Total Expenditures		$4,152.26

TOTAL RECEIPTS

Per Cap Tax from the branches	$3,149.28	
Sale of Supplies to the branches	140.00	
Sale of Convention Reports to the branches	117.63	
Sale of Convention Reports to the members	391.11	
Interest on Bank Account	74.71	
	$3,872.73	
Total Receipts		3,872.73
Deficit for Year		$ 279.50

Recapitulation

Total Cash on hand June 1, 1929	$2,642.05
Total Receipts for year	3,872.73
Total	$6,514.78
Total Expenditures for year	4,152.26
Total Cash on hand June 1, 1930	$2,362.52

$1,571.55 of the above funds are on deposit in the Savings Account with the Bankers Trust Co. of Philadelphia, Pa., the balance, $791.00 are on deposit in the check account of the Bankers Trust Co., Philadelphia, Pa.

Respectfully Submitted, June 20, 1930,

GEORGE GEHLING,
Secretary-Treasurer.

BRANCH	Members June 1, 1929	Elected	Reinstated	Suspended	Resigned	Died	Loss by Transfer	Gain by Transfer	Total Members June 1, 1930	Receipts from Branches: P. C. T.	Supplies	Convention Reports	Balance Due from Branches
Balto.-Wash	34	4	..	2	..	1	1	..	34	$ 72.97	$ 5.00	$ 3.63	.....
Boston	11	23	..	5	..	..	..	1	30	57.75	7.00	.....	.....
Bridgeport	55	12	..	2	1	..	1	..	63	125.47	4.00	7.31	.....
Chicago	207	26	3	11	1	3	3	2	220	444.14	8.00	3.76	.....
Cincinnati	38	1	..	6	..	1	1	..	31	136.50	2.50	7.42	.....
Cleveland	42	1	..	2	..	..	1	1	41	87.67	5.50	7.17	.....
Dayton	31	5	..	..	..	..	..	1	37	69.81	8.00	3.67	.....
Detroit	71	20	1	8	1	..	..	..	83	204.22	5.50	3.71	.....
Grand Rapids	31	2	..	..	..	..	..	..	33	66.14	2.50	3.67	.....
Hartford, C. V.	41	7	..	3	..	..	..	..	45	88.19	5.50	3.73	.....
Indianapolis	23	7	..	1	..	..	..	..	23	49.87	4.00	3.67	.....
Los Angeles	23	60	..	..	..	..	..	9	92	117.59	17.00	3.92	.....
Milwaukee	58	4	1	5	..	..	1	..	57	92.39	2.50	3.76	$33.92
Montreal	20	3	..	2	..	..	..	..	21	42.00	2.50	11.13	.....
New York	115	15	..	7	1	2	..	2	122	242.01	17.00	3.67	.....
Newark	104	18	..	..	..	..	2	..	120	234.14	11.00	3.64	.....
Philadelphia	120	15	2	4	2	1	..	1	131	253.57	5.50	3.50	.....
Pittsburg	36	8	..	..	..	..	..	..	44	82.42	5.50	3.63	.....
Providence	34	4	..	5	..	..	..	..	33	55.11	3.50	3.67	20.32
Rochester	74	13	..	11	1	..	..	..	75	154.34	4.00	3.67	.....
St. Louis	63	3	..	1	2	1	..	..	62	165.36	4.00	3.76	.....
Toronto	67	..	..	1	1	..	..	..	65	135.44	2.50	3.77	.....
Toledo	26	2	..	..	..	..	..	..	28	42.00	2.50	14.49	14.70
Waterbury	33	2	..	..	1	..	..	..	34	85.57	2.50	3.67	.....
Worcester	22	4	..	..	..	1	..	..	25	44.61	2.50	3.67	.....
Totals	1379	253	7	76	11	10	10	17	1549	$3149.28	$140.00	$117.63	$68.94

EDITOR'S REPORT, 1929-1930

May 31, 1930.

To the officers and members of the American Electro-Platers' Society herein assembled, in annual meeting and convention I again submit to you the annual report of the Editor's Office for the year (fiscal) ending May 31, 1930.

It is my pleasure to report that the review, printed 12 issues—5 forty pages 4 forty-eight page and 3 fifty-six page issues in an endeavor to keep the amount of papers and branch news up to date, also to give donors of papers an opportunity to compete for the prize awards of the year in which their articles were written, lest at a later date the publishing of same might millitate against value of the paper or in presence of other articles along similar lines cause confusion in judging same for prizes.

The financial side of this department of the Society is usually included in our Sec.-Treas. report. Therefore we have given it no space in this report.

The quality of the papers sent in for publication was of the usual high standard of previous years, and the amount of con-

tributions, we believe, far exceeded any previous years. It begins to look as though the members have suddenly become aware of their power to write, and the A. E. S. can feel proud that it is developing confidence and unselfishness of its members as is manifested by the growth of our Review, necessary to take care of this influx of information and additional branch news.

It has been asked why we do not issue our review on the first of each month or call issue that goes out June 1st June issue. In answer we will state that the men who have been the editors in the past have tried to include the branch news of each month in the issue of the month in which such news was intended to be of interest. The papers which usually appear in the Review can all be read in the complete convention report or in the first six issues, so it is assumed that the branch news and their activities are the interesting items. Hence reason for printing the Review at end of month.

We also have tried to keep the records of this office in as simple manner as is possible, and, as was done by our predecessors, that it would be easy for any members of the Society if elected to this office to follow out the details and still follow the profession of plating to earn a living. We realize that many records and much detail could of been added to the methods that are now in vogue, but we also feel that if such had been made a part of the itinerary of this office record, it would probably narrow down the candidates for this office to a certain class of members and cause many differences in selection of the suceeding candidates for editor; and in consideration for the former editors and makers of our constitution, who we believe have tried to preserve many landmarks and customs of the fundamental principles of this Society, which the progress of times are liable to cause deviation and much chaos therefrom for the editor and his staff.

The editorial staff wishes to thank the many contributors for their fine co-operation during the past four years, also thank the branch officers and members for their goodly support and prompt sending of monthly reports to the Review.

The editor also takes this opportunity to thank his associate editors for their assistance during his term of office and everybody in the Society for the patience and kind consideration accorded to him during his entire tenure of office in the Society and I hope

that the succeeding editor may have the same even tempered justice meted out to him.

Four years ago we started with 1,100 24-page copies each month and finished June, 1930, with 1,600 copies of 56 pages of which 1,575 are distributed each month and balance used to replace lost and extra copies called for by our members and contributors to our research fund and exchanges with foreign societies with which we are allied.

For some unknown reason to the editor there has never been an office file of Reviews kept, but since taking this office I have started such a file for reference and due to many requests for reprints of old papers, and hope that same may be kept up, as I think it will be an asset to the office in the future.

It is with reluctance that I now, according to custom of our society, must leave your service as editor, and while I am loath to do so, I feel that our custom is a good one, although it is an unwritten one it surely proves that our ideals are wholly of an unselfish nature, and the ambition of members to serve this Society sometimes may cause them to say things that sound very unethical, yet I believe that there is not a better, more courageous or unselfish body of men in the world than the American Electro-Platers' Society, and I can see naught but more success for them each year, while the same spirit of mutual education spurs them on. How little did the founders of the Society know how well they had built the foundation.

In conclusion, I want to thank the many presidents, vice-presidents, secretaries and executive boards and branch officers it has been my pleasure to work with, for and to direct during the past nine years of activity as a supreme officer. I thank you.

F. J. HANLON, Editor.

THE NEW ELECTRO PLATING INSTALLATION AT THE GILLETTE SAFETY RAZOR CO., BOSTON

By Floyd T. Taylor, Vice-Pres., A. P. Munning & Co., Matawan, N. J.

The object of this paper is to point out the solution of a problem of quality electro plating, combined with a large scale commercial production.

The electro plating plant of the Gillette Safety Razor Company in Boston has been selected as the example to be described, because, while their product is unique, the precision required to pass their inspectors means that successful equipment furnished to them illustrates production electro plating at its best. Furthermore, practically any kind of plating, of any sized article and any volume of continuous production can be handled by using the same general layout as installed by the Gillette Company.

In order to explain the problem, now solved by the new plating room, presently to be described in detail, let us spend just a moment to outline the character of the product of the Gillette Safety Razor Company and their production growth up to the present time. Also take note that expected growth is provided for in the new layout.

From the outset of its business career, quality has been the watchword of the Gillette Company and nothing whatsoever has ever been allowed to interfere with this watchword of quality above all. New methods are checked first and foremost to ensure a maintainance of quality and unless it is first established and later demonstrated that the proposed changes will still maintain, or improve, the quality of the finished article, no further attention is paid to any proposed change of method.

The products made are the holder, consisting of five separate pieces, assembled after plating to three parts, called the guard, the cap and handle, all made of a special brass and all polished and electro plated with gold, silver or nickel as desired for final finish. The making of the steel blades is an industry in itself. Other articles manufactured are such as metal razor boxes, blade boxes, soap boxes, surgical knife handles, chiropodists chisel handles, carpet pile wires, textile edges, string cutters and the office knife.

As the making of blades represents one form of metal finishing, the general process of making the blades will be described briefly. The steel in a continuous ribbon is fed into automatic presses which punch out the blanks in two rows and deliver these blanks to a canvas conveyor belt to carry them to a washing machine.

The blades are then assembled in frames and put through the tempering process, after which they are tumbled for twenty-four hours to remove the heat scale and to burnish.

From the tumbling barrels they pass through several different types of automatic sharpening machines which form and finish the cutting edges. Rigid inspections are maintained at each step of this process, but the final inspection is of course the most interesting and the most exacting.

The organization of the Final Blade Inspection Department is unique. The department of about three hundred girls is under the supervision of the chief blade inspector who is assisted by a foreman and forewoman. There are eighteen section supervisors each of whom have direct charge of a section of sixteen girls. Each section is made up of ten inspectors who carefully inspect every blade, five reinspectors who check the work done by the first ten inspectors and one floating inspector who substitutes for absentees or does other work as may be necessary.

The Employment Manager uses the utmost care in selecting employees for this department and each applicant must pass an extremely rigid eye examination before being accepted for the inspection training course which covers a period of seven weeks.

The blades are inspected and reinspected and every blade which shows the slightest defect of any kind is rejected. Only one grade of blades are sent along from this department to the packers and that is the perfect shaving blade. Every possible precaution is taken to maintain the high standard of quality on which the Gillette Company's reputation is built.

From this final inspection the blades go to automatic machines which wrap them in a waxed paper shield, sealed with water free vaseline. The daily production of blades at Boston at present is two million two hundred thousand blades in eight and two-thirds hours, and these blades are sent all over the world, where they comfortably make men more like humans and less like animals. So much for the blade making.

In order to give a clearer picture of the polishing and plating as done at present it seems well to trace the development of metal finishing by the Gillette Company since the rapid growth of production requirements has of course been the cause of the various expansions of the polishing and plating departments.

In 1902 the Gillette Company rented a loft and installed these two activities in it. Exact records of the equipment used are not

available, but it is still remembered that the department had a large surplus capacity. Yet the following year a plant of still larger size was needed and this plant when finished was considered a model which others might do well to copy. The total power was supplied by a 5 H. P. motor, which served buffs, scatch brushes and the plating dynamo. Two small silver plating tanks, a crock for gold and the expected auxiliary dips and rinses completed the equipment. All the plated parts were hand burnished after plating with the familiar blood stone burnishers. Skill and eternal vigilance were the only controls used and yet it is doubtful if any article has ever been produced with a more satisfactory electro plate. It is this standard of quality that is now being maintained, just as rigidly as ever, but on a volume production inconceivable, with strictly manual handling.

With automatic handling, modern, electrical and chemical controls are used, nevertheless, it must be remembered that those who plan to eliminate human skill entirely from a job of fine electroplating are probably planning a failure and facing a disaster.

The plating department was increased in 1907 to eight tanks, producing one thousand razors per day with a crew of four men to handle the work.

In 1909 the plating room was enlarged again and bright silver solutions installed to eliminate some of the hand burnishing.

In 1915 the first attempts at automatic control were made through the installation of Sangamo Meters.

In 1917 with a normal production of four thousand razors per day, the Government placed orders for supplies for the Army and Navy that required a production of thirty-five thousand complete razors per day—or more than one hundred seventy-five thousand separate pieces to be plated. To care for this production twenty-four nickel tanks of one hundred and fifty gallons each were installed and the pay roll of the plating department showed the employment of sixty-five men and seventy-five girls.

After the war, instead of reduced production, the demand grew steadily and the following changes were made in an attempt to keep up with the production requirements:

First: The use of racks designed by Gillette engineers to hold one hundred parts for plating and supplanting the old wiring system which accommodated but five pieces to a wire. This saved a tremendous amount of time and labor.

Second: Adopting semi-automatic plating tanks of the screw conveyor type for nickel and silver plating.

Third: Installation of automatic plating barrels for the smaller razor parts.

Fourth: Eliminating hand scrubbing and cleaning work by adopting automatic cleaning processes.

None of these improvements were adequate nor did the mere expansion of tank capacity in the shape of semi-automatic conveyors cope with the problems of uniformity, continuity of production, space or labor.

Consequently faced with a daily production of seventy-five thousand complete razors, and a corresponding number of metal cases and miscellaneous parts in nine hours, and to take care of peak demands, the further specification of one hundred and fifty thousand complete razors and accessories to be finished by operating twenty hours per day, the Gillette engineers set to work, with their accustomed thoroughness, to analize their problem, and to consider, not only available apparatus, but also, what changes or improvements in existing designs were necessary to solve their problem. More than nine months were devoted to an intensive study of the problem from every known angle and every questionable suggestion was carefully checked. For the sake of the emphasis it deserved, let it be restated that maintenance of quality ranked first and inviolate throughout all this planning.

Now the layout selected to solve their problem is this: First: That a group of plating barrels, with the cleaning and rinsing tanks needed for barrel plating be installed and that this group be served by a simple monorail hoist and crane.

Second: That all parts requiring either wiring or racking be cleaned, rinsed, bright dipped, rinsed, plated, rinsed and dried on full automatic continuous chain conveyors.

The plant as installed will now be described as far as its principal details are concerned and this description will be illustrated by lantern slides showing first the superseded plating room and then the new plant.

The polishing of the various pieces composing the razor handle is done on automatic machines developed by the Gillette engineers themselves. For cutting down tripoli is used, for final coloring rouge is used for gold and silver and lime for nickel. Burnishing, when required, is done by rolling on polished steel plates. The polishing is all done in a separate department entirely distinct from the plating.

The plating room occupies the top floor of the new nine-story concrete addition to the Gillette plant. Endless belt and ladder type chain conveyors deliver the work to the plating room from the floors below. A lantern slide to be shown presently will give a clear idea of the arrangement of the various machines as installed. For the moment let us consider merely some of the features of the apparatus.

Starting of course with the generation and distribution of the electrical energy, the following facts will be of interest. The motor generators consist of Munning OPTIMUS Generators driven by General Electric Induction Motors. These sets are installed in a separate glass enclosed room, ventilated from the outside. The switchboard containing the starting compensators, meters, and generator field regulating rheostats, is also mounted in this room. Flat copper bus bars in strips mounted on edge and separated for ventilation, carry the current to the electrified tanks. The copper section is distributed on the basis of five hundred amperes per square inch.

The complete list of motor generator sets and their application is as follows:

Amperes	Rated Voltage	For
1000	12	Direct Electric Cleaner
2000	6	Reverse Electric Cleaner & Plating Barrel
2000	4½	Nickel Conveyor
1500	3	Silver Conveyor
300	6	Gold Conveyor.

Automatic voltage regulating relays control the separately excited shunt type generators that supply current to the gold, silver and nickel conveyor plating tanks, and therefore the drop from anode to cathode in these tanks remains constant at any desired value regardless of the load in the tank. These regulators prevent burning of the work and they make it possible to secure a uniform current density. Separate tank regulating rheostats of the parallel coil type, each furnished with a volt meter and ammeter, are installed on all other plating tanks.

Before describing the plating room equipment itself, let it be noted that the time cycles determined by actual test will be given, because they are both interesting and correct for the work they do. However, these time cycles are flexible so that the required deposit can be applied to the several quality classes.

Furthermore, for various reasons, the principal of which is the

elimination of argument on the details of solution, composition and control, it is outside the scope of this paper to give formulas, current densities and the like. Let us confine ourselves to the mechanical details and general dimensions.

Considering now the conveyors, in general they consist of a continuous overhead chain conveyor supported from the ceiling and mechanically independent of the tanks they serve. All three are arranged for end loading and unloading so that one attendant loads and unloads each machine.

Effective exhaust hoods carry away fumes without impairing the accessibility of the complete machine.

All the tanks are of ¼ in. steel of the rivet and double weld type. The tanks carrying acid solutions are lined with fifteen pound chemical lead. The tank for the gold solution is glass lined and jacketed for hot water heating.

1. Load .....
2. Hot Soak .....11 1/6 min.
3. Hot Rinse and Spray.....38 sec.
4. Electric Cleaner .....5 min.
5. Reserve Electric Cleaner.....38 sec.
6. Cold Rinse & Spray.....38 sec.
7. Cyanide Dip .....38 sec.
8. Cold Rinse and Spray.....12⅓ min.
9. Cold Rinse and Spray.....38 sec.
10. Gold Plate .....4½ min.
11. Gold Rinse (Reclaim).....1 min.
12. Cold Rinse and Spray.....38 sec.
13. Hot Rinse and Spray.....38 sec.
14. Dry—Hot Air .....5 min.
15. Unload .....

The principal dimensions of the conveyor are:

Center to center of work hangers.....16 in.
Normal chain speed per minute.....11 in.
Time of transfer, approximately.....33 sec.
Height of lift.....28 in.
Total length of tanks on floor (approximately).....40 ft. 5 in.
Total width of tanks, approximately.....6 ft. 6 in.
Headroom required .....10 ft.

The Silver Conveyor is novel in that a single overhead chain conveyor serves two parallel sets of tanks so that both bright and dull silver plating can be done on a single machine depending

merely on whether the racks are hung on the inside or outside end of the work hanger cross arm. The standard time cycle for bright silver is:

1. Rack .....
2. Hot Soak .....9⅔ min.
3. Hot Rinse and Spray.....28 sec.
4. Electric Cleaner .....3 1/5 min.
5. Reserve Electric Cleaner.....24 sec.
6. Cold Rinse and Spray.....24 sec.
7. Cyanide Dip .....24 sec.
8. Mercury Dip .....24 sec.
9. Cold Rinse and Spray.....44 sec.
10. Silver Strike, No. 1.....24 sec.
11. Silver Strike, No. 2.....1⅓ min.
12. Cold Rinse and Spray.....3⅔ min.
13. Silver Plate .....30 min.
14. Cold Rinse and Spray (Reclaim).....24 sec.
15. Cold Rinse and Spray.....44 sec.
16. Hot Rinse and Spray.....24 sec.
17. Unload .....

The standard cycle for the dull silver is:

1. Rack .....
2. Hot Soak .....9⅔ min.
3. Hot Rinse and Spray.....28 sec.
4. Electric Cleaner .....3 1/5 min.
5. Reserve Electric Cleaner.....24 sec.
6. Cold Rinse and Spray.....24 sec.
7. Cyanide Dip .....24 sec.
8. Cold Water .....24 sec.
9. Cold Rinse and Spray.....44 sec.
10. Silver Strike, No. 1.....24 sec.
11. Silver Strike, No. 2.....1⅓ min.
12. Cold Rinse and Spray.....3⅔ min.
13. Silver Plate .....30 min.
14. Cold Rinse and Spray (Reclaim).....24 sec.
15. Cold Rinse and Spray.....44 sec.
16. Hot Rinse and Spray.....24 sec.
17. Unload .....

The principal dimensions of this conveyor are:

Center to center of work hangers.....16 in.
Normal chain speed per minute.....15 in.

Time of transfer, approximately.....24 sec.
Height of lift.....28 in.
Total length of tanks on floor (approximately).....51 ft. 1 in.
Total width of tanks, approximately..... 6 ft. 6 in.
Headroom required .....10 ft.

The nickel conveyor is based on the following time cycle:

1. Rack .....
2. Hot Soak .....10 min.
3. Hot Rinse and Spray.....36 sec.
4. Electric Cleaner .....3.5 min.
5. Reverse Electric Cleaner.....36 sec.
6. Cold Rinse and Spray.....21 sec.
7. Cyanide Dip .....21 sec.
8. Cold Rinse and Spray.....21 sec.
9. Cold Rinse & Spray.....3 min.
10. Nickel Plate .....15 min.
11. Cold Rinse and Spray.....21 sec.
12. Hot Soap Dip.....21 sec.
13. Hot Rinse and Spray.....21 sec.
14. Dry—Hot Air .....3⅓ min.
15. Unload .....

And its principal dimensions are:

Center to center of work hangers.....16 in.
Normal chain speed per minute.....20 in.
Time of transfer, approximately.....18 sec.
Height of lift.....28 in.
Total length of tanks on floor (approximately).....53 ft. 1 in.
Total width of tanks, approximately..... 6 ft. 9 in.
Headroom required .....10 ft.

The holding capacities of the standard racks used on these conveyors is as follows:

Caps and Guards.....	150
Tubes	70
Cases	10
Soap Barrels	30
Soap Covers	50
Soap Inner Caps.....	100

So much for a description of the conveyors.

The plating barrel equipment is divided into two sections so that the large size machines for silver and nickel together with their cleaning, rinsing and dipping tanks and dryer, is separated from a similar group of jewelers type plating barrels and auxil-

lary equipment for the parts plated with gold in plating barrels.

Six single cylinder Munning Optimus Type E 20 machines are required for silver plating, two single cylinder Munning Optimus Type E 20 machines do the nickel plating and two Munning Optimus Jewelers Plating Machines take care of the gold plating.

Just a word on anodes—For Gold anodes assaying 24 carats are used. For Silver the anodes are 999 fine, and for nickel 99.9 per cent electrolytic nickel is used.

Lacquering of Gold and Silver razors is done on a ladder chain dip lacquering machine located three floors below the plating room.

A special feature of the Gillette layout worthy of note is that of acid handling.

The sulphuric acid used in the plating room is stored in a tank located in the street from which it is pumped by an air lift pump to the plating room on the ninth floor into a reserve tank from which it is drawn as needed.

As this new plating room is just being put into operation, it is too early to give performance figures. It is already evident, however, that the expectations of those responsible for the design, installation and operation of the apparatus are to be achieved, and that the problem of the Gillette Company has been solved correctly.

The layout represents joint effort, the equipment was furnished by A. P. Munning & Co. and the installation was supervised by their engineers. The spirit of cooperation between the Gillette Company and A. P. Munning & Co. produced a completed job in record time and represents modern industrial relations at their very best.

LOS ANGELES BRANCH

The regular monthly meeting of the Los Angeles Branch was held as usual on the second Wednesday of the month at the Elite Cafe.

Thirty-eight sat down to dinner after which M. McNulty took the chair and installed the officers for the ensuing fiscal year. After the installation was completed the new officers were given a big hand, this being a Grotesque hand, 24x36 inches, which a couple of the members carried in, and created an uproar of laughter and applause.

The minutes of previous meeting were read and approved. The Board of Managers reported the Audit of the Branch's books showing a balance of $312.48 for the end of the fiscal year.

Among the communications, letters were read from Mr. Hogaboom and Mr. Gehling and were well received.

Owing to the fact that no one from the Los Angeles Branch is attending the Convention, it was decided by the members that the St. Louis delegates be appointed proxy for the Los Angeles Branch with instructions to vote against the "Admission of assistant platers to the

Society and to vote in favor of resolution: that Section 3, Article 12 be stricken from the constitution."

Owing to the lack of information on the subject of Incorporating the Society, we could not express an opinion at this meeting.

The Branch acted favorably on the suggestion of Past President Geo. B. Hogaboom.

Librarian Bob Gripp took over the meeting and promised to have plenty of material for discussion at all coming meetings, members agreeing to assist him.

Mr. Gripp found the following questions in the box:

Question 1. What dipping process is used to finish aluminum alloys in an imitation iron or grey black, and what neutralizing dip should be used afterwards, preparatory to lacquering?

Answer 1. Dipping process is composed of the following: 1 gal. water, 1 pint Muriatic acid, 4 oz. arsenic, 4 oz. carbonate of iron, to be used about 100 degrees F. Neutralize in very weak solution of Sal Soda.

Question 2. What must be done to soften a deposit in Cyanide Copper solution?

Answer 2. Help.

Question 3. How do you Chromium plate a fancy bordered tray about 12x16 inches?

Answer 3. Secretary Rynkofs answered this question with a drawing on the blackboard.

Question 4. How to Chromium plate a radiator shell without shading the sides near the hoodband recess?

Answer 4. Secretary Rynkofs also illustrated this one along with various other racks used to hold articles to be Chromium plated.

The question for the next meeting is, "How to prevent pitting in nickel plating."

The meeting adjourned at 11:30 P. M.

M. D. RYNKOFS, Secy.-Treas., Los Angeles Branch of A. E. S.

CLEVELAND BRANCH

The regular monthly meeting of Cleveland Branch was held June 7th at Hotel Winton. The meeting was called to order by President Paul Stamm at 8:15 p. m.

After the minutes of the previous meeting were read and approved the chair called on Mr. Charles H. Proctor, who was our surprise guest of the evening, to install the officers for the ensuing year.

The following officers were installed:

President, Mr. E. Steen Thompson.

Vice President, Mr. H. J. TerDoest.

Secretary Mr. Paul R. Stamm.

Librarian, Mr. W. D. Scott.

Board of Managers, Mr. J. C. Singler, Mr. N. E. Zadowski and Mr. Wm. Edward Oberg.

President Thompson then took the chair and the regular order of business was carried out.

The chair called on Mr. Proctor to initiate our new member Mr. Joseph Bedo.

The business of the meeting finished, the chair called on Mr. Proctor to say a few words, Mr. Proctor replied in a splendid manner and the members showed their interest by asking questions. We enjoyed Mr. Proctor's visit and hope he will call again.

There will no July meeting of our Branch.

PAUL R. STAMM, Secy.

At the last meeting of Waterbury Branch, the following officers were elected; President, Wm. J. Gray; vice president, Barrie Hachett; secretary-treasurer, Wm. F. Guilfoile; lecturer, Wm. Cavanaugh; assistant, Ellsworth Candee; board of managers, Joseph Muscio, Leroy Miller and Henry Wahlstedt. Delegates to Washington, D. C. convention, Wm. F. Guilfoile, Wm. J. Gray and Wm. Delage. Alternates, Barrie Hachett, Andrew Perrin and Joseph Muscio. Ralph L. Brandeley, foreman of the Waterbury Clock Co., was elected to active membership. Favorable action was taken in communication from George B. Hogaboom. Annual report of secretary-treasurer was received and accepted. Delegates to convention received instructions in matters pertaining to same. Aside from the delegates, it is expected that Waterbury will be represented by the largest delegation that has attended a convention in years.

WM. F. GUILFOILE.

MILWAUKEE BRANCH

At our last regular meeting which was held June 12, 1930, 32 members attended. President Ed Werner called meeting to order, after regular business, new officers were installed. Master of ceremonies was Mr. Ray Goodsell of Racine, Wis. Officers: President, M. Nishwitz; vice president, P. Krause; secretary-treasury, John N. Hock; librarian, H. Binder; assistant, A. Koehler; board of managers, R. Steurnagle, F. Marx, Ed J. Geisman. The members promised our new president to attend all meetings possible, and hope to have full attendance hereafter. Meeting adjourned, 10:10 p. m. after which all enjoyed lunch and refreshments.

Yours truly,

JOHN N. HOCK, Secy-Treas., Milwaukee, Wis.

BRIDGEPORT BRANCH

Minutes of Meeting—June 13, 1930

Roll call of officers—All present.

A motion was made and seconded that the books of the branch be turned in at the next meeting to the Board of Governors, for an audit.

Delegates to the national convention were instructed to support George Gehling, the present supreme secretary, for president. They were also instructed to vote for the new amendment to the constitution, allowing assistant plating foremen to become members of the Society, upon recommendation of their foreman.

Motion made and seconded that the next regular meeting be held

July 11th, 1930. Mr. Wagstaff appointed Mr. B. Flaherty and John Raull as members of the sick committee.

Also appointed the following members on the speakers' committee: T. H. Chamberlain, chairman; Ray O'Connor, John Oberender, George Knecht.

Suggestions were made that a definite program be made up for the coming year. Also that return postals be sent to the members asking them for suggestions of subjects for these meetings.

NEW YORK BRANCH

The regular meeting of New York Branch A. E. S. was held at World Bldg., Park Row, June 13, 1930. Mr. F. Haushalter, presiding. Mr. Figliazzi was elected as active member.

We had a fine delegation from Newark Branch including Supreme President, Mr. Horace Smith, who installed the new officers, his talk was brief and asked the New York members to give full support to the new officers.

Question was asked for a cheap rose gold finish. The following answers were given:

1. Gild article and paint with a mixture of chrome yellow and Venetian red, mixed to desired color with turps and little varnish for a binder.

2. Make a saturated solution of carbonate copper dissolved in muriatic acid for a smut, then pass through a concentrated solution of sodium chloride to clear smut, gild and relieve.

3. Copper articles in copper solution low in cyanide, on the green side, luke warm, then pass through silver nitrate solution ¼ oz. to gal., gild and relieve.

Second monthly meeting was held on June 27. President F. Haushalter presiding. Meeting opened 8:45 p. m.

Secretary read a copy of letter sent to the Branches by New York Branch against the amendment of admitting assistant foremen in the A. E. S., he read a number of letters from branches who were also against the amendment.

The use of cadmium anodes in a zinc solution for a whiter and brighter deposit was taken up, one member stated he was getting fine results by this method, his work held no longer under the salt spray test. The pros and cons were freely discussed.

Meeting adjourned 11:45.

ARTHUR GRINHAM, Rec. Secy.

HARTFORD-CONNECTICUT VALLEY BRANCH

The Hartford-Connecticut Valley Branch, A. E. S., held its regular monthly meeting on June 23, 1930, at the Springfield Chamber of Commerce Rooms, Springfield, Mass.

The meeting was called to order at 8:15 p. m. with President Beloin in the chair. Minutes of the previous meeting was read and approved. No bills were presented. All communications were read and placed on file.

It was voted to donate five dollars to the fund as described by Mr. Hogaboom's letter. It was also voted to instruct our delegates to vote in favor of the amendment to be presented by the Newark Branch at the Washington convention.

Through a vote of the branch it was decided to suspend our regular meeting through the months of July and August. Our next meeting will be held in September at the Hartford Chamber of Commerce. We are going to try to secure as speaker for our September meeting, Dr. L. C. Pan, instructor of Electroplating at the College of the City of New York.

Mr. C. R. Prescott of the New Haven Sheradizing Co. of Hartford, Conn., was the speaker for the evening. He gave a very interesting and instructive talk on cadmium plating as done in job shop work. The members who missed this talk missed a talk that was worth while. The talk was made more interesting by some samples of the work. Mr. Prescott's talk was enjoyed by all of us. In conclusion he was given a rising vote of thanks.

The meeting was attended by sixteen members and adjourned at 10:30 p. m.

V. E. GRANT, Secy.

ROCHESTER BRANCH

Rochester Branch held their monthly meeting at Powers Hotel and elected officers for the coming year. President, Clarence Reama; vice president, Wm. D. Hart; secretary-treasurer, Charles Griffin; librarian, Judson R. Elster; board of managers, S. P. Gartland, Frank Mesek, Raymond Lopez; delegates to national convention, S. P. Gartland, Raymond Lopez, Chas. Griffin; alternates, Harry W. Puffer, F. J. Kohlmeier, J. W. Snyder. Rochester delegates were instructed to do all in their power to bring the 1931 convention to Rochester.

CHARLES GRIFFIN, Secy.

CHICAGO BRANCH

The 220th regular monthly meeting of Chicago Branch, A. E. S., was held Saturday, July 12, 1930 at the Atlantic Hotel. Meeting was called to order by P. P. Frank Hanlon, who called upon our newly elected Supreme Secretary, H. A. Gilbertson, to act as Vice President.

The delegates gave their reports and it was gratifying to know that the convention was such a great success, considering that it was held so far south in the middle of summer.

After the usual business of the Branch was transacted, the meeting was turned over to our Librarian, Mr. O. E. Servis who found the following questions in the box:

Question No. 1. I am having trouble with rough deposit in nickel plating since using 99+ anodes depolarized. How can I overcome this trouble?

Answer No. 2. There was not enough information given with this question. Several suggestions were made however. Too high current

density; too much chlorides in sol.; too much mud in bottom of tank.

Question No. 2. I have a sulphuric strip 95 per cent acid, 5 per cent water. This strip is about 2 years old, have been adding acid as needed, just recently there seems to be considerable mud in the boiler, it is very thick and heavy, what causes this and how to overcome?

Answer No. 2. This mud forms during electrolysis and can not be prevented. When enough of this mud forms to cause inconvenience it should be removed.

Question No. 3. What is best cleaner in nickel plated buff and colored cold rolled steel parts before chrome plate? What temperature and voltage to use?

Answer No. 3. Any of the standard mild cleaners can be used or if you prefer to make your own cleaner try—Trisodium phosphate, 4 oz., caustic soda, 2 oz., add a little cyanide occasionally; temperature 140 to 160 degrees; voltage 5 to 6.

Question No. 4. Ph. of nickel sol. is 6; metal and chlorides O. K., but deposit is dark.

Answer No. 4. It was suggested that the sol. might have become contaminated with zinc or copper.

Question No. 5. What is the highest Ph. that can be used in a nickel sol.?

Answer No. 5. Under ordinary conditions the Ph. range for a nickel plating sol. is from 5.2 to 6.8. A Ph. of 5.8 or 5.9 is considered pretty good for general all around work. Special conditions may require that the Ph. deviate up or down.

Members Please Note

When you write to the question box, please give as much information as possible. Factors that we should know are, type of sol., current density, temperature, anodes, Ph. and any other conditions that you may notice besides your trouble.

J. C. KRETSCHMER, Secy.

LOS ANGELES BRANCH

The regular monthly meeting of the Los Angeles Branch was held as usual on the second Wednesday of the month, July 9, at the Elite Catering Co. Forty sat down to a well prepared dinner. The meeting was called to order with President C. E. Thornton presiding and all officers present, except Vice President E. W. Francis, who is on his vacation on the desert catching fish. The minutes of the previous meeting were read and approved. Bills were ordered paid.

Mr. E. R. Williams and C. S. Rockhill, the former from Orlando, Florida, member of the Chicago Branch and Mr. A. Leimer from Detroit were present at the meeting for their first time since arriving in the Angel City.

The members at this meeting voted to hold the annual smoker meeting on October 8. Frank Rushton was appointed chairman of the affair. The smoker is looked forward to as an opportunity for every-

one interested in the craft to get together and give their views on the plating industry on the Pacific Coast.

After the regular order of business the meeting was turned over to the Librarian, R. Gripp, who found the following questions in the box:

Question 1. Can iron be removed from a Chromium solution and how?

Answer 1. The expense of removing iron would be prohibitive, it was a general opinion to throw it out and make a new one.

Question 2. How do you stop water stains on Chrome Plating?

Answer 2. Rinse with plenty of water.

Question 3. Is anyone using Muriatic Acid Strip and what success? Give proportions.

Answer 3. Several present expressed their satisfaction with a Muriatic Strip composed of three gallons acid and one gallon of water. Plenty of lead surface with reverse current.

Question 4. What should the Baume reading be in an Electric Strip made of Sulphuric and Glycerine? What happens if Baume is too high?

Answer 4. Reading should stand at fifty-two. If Baume is too high, stripping time is lengthened.

The subject "Nickel Pitting" schedule for this meeting proved to be very educational to all present.

Secretary Rynkofs exhibited samples of Nickel Pitted articles plated in a solution standing Ph. 6.3 Metal content at 3¼ oz. using 99 per cent anodes and compared them with the same type of articles, plated in the same solution, using 90-92 per cent anodes which were almost immune from pits. He also explained the results of a test in diluting the above solution 33 per cent, using the 99 per cent anode which plated without pitting. The Secretary made an appeal for other members to make similar tests, in order to corroborate his results. The subject, however, was to be continued to the August 13th meeting.

The meeting was adjourned at 10:30 p. m.

M. D. RYNKOFS, Sec.-Treas.

APPLICATIONS

	Branch
Henry Weber, active, 4247 Archwood Ave., Cleveland, Ohio	Cleveland
Anthony Messano, active, 1029 Leggett Ave., N. Y. C.	New York
Wm. Jackman, active, 99 Jewell St., Brooklyn, N. Y.	New York
Ralph H. Lee, assoc., 1066 Gerard Ave., N. Y. C.	New York
L. Ray Soper, active, Elmira, N. Y.	Rochester
Jos. Baker, active, Kankakee, Ill.	Chicago
G. A. Winnebury, active, 2602 W. 15th Ave. S., Minneapolis, Minn.	Chicago
Ramond Landgraf, active, 5832 E. Circle Ave., Chicago, Ill.	Chicago
Frederick Glitzen, active, 159 Dickenson St., Rochester, N. Y.	Rochester

ELECTIONS

	Branch
Willis Harvey, 126 Allen Rd., R. R. No. 1, Grand Rapids, Mich.	Grand Rapids
John B. Fighazzi, 2129 85th St., Brooklyn, N. Y.	New York
Chas. W. Rurk, 4928 N. Mansfield Ave., Chicago, Ill.	Chicago
Geo. C. Muscio, Y. M. C. A., Wood and 3rd Sts., Pittsburgh, Pa.	Pittsburgh
Richard Rimback, 1117 Wolfendale St. N. S., Pittsburgh, Pa.	Pittsburgh
Ralph W. Prinz, Apt. 2, 1614 Joseph Bond Hill, Cincinnati, O.	Cincinnati
Thos. Baker, 149 Earlston Ave., Coventry, England	Philadelphia
Jas. N. Griffin, Plymouth, Ind.	Indianapolis
Ralph L. Brandely, P. O. Box 396, Oakville, Conn.	Waterbury
Wm. H. Tuttle, 11 Harding Terrace, Hillside, N. J.	Newark
Chas. W. Neild, Box 1444 Journal Sq. P. O., Jersey City, N. J.	Newark
Bert W. Sage, 118 Orchard St., Newark, N. J.	Newark
Chas. G. Whitehead, 1358 Rector St., Perth Amboy, N. J.	Newark
Edward F. Moulder, 111½ Susquehanna St., Binghamton, N. Y.	Rochester

RESIGNATIONS

	Branch
Joseph Dinan, Jr., correction June report	Philadelphia
Samuel Stearns	Waterbury
Harold Pierson	Waterbury
Urban A. Mullen	Newark

DEATHS

	Branch
Laurence A. Sheridan	Newark

REJECTIONS

	Branch
Samuel Geffon, correction June report	New York

SUSPENSIONS

	Branch
Francis J. Spaine, 1323 North Ave., Bridgeport, Conn.	Bridgeport
John W. Bremer	Cincinnati
C. M. Kelley	Cincinnati
Guy Gregory	Boston
Albert E. Howe	Boston
J. J. Gorman	Boston
Harry Wright	Boston
Harry Carr	Detroit
A. J. Fritz	Detroit
Chas. W. Heath	Detroit
Arthur Sutcliffe	Detroit
Wm. W. Ream	Detroit
Wm. Shepperd	Detroit
A. E. Shepperd	Detroit
David H. Moss	St. Louis
C. C. Cromer	Indianapolis
Leonard C. Barber	Indianapolis

BALTIMORE-WASHINGTON

Meets in Enoch Pratt Library, Calhoun and Hollins Sts. Geo. F. Turner, Secretary, 5324 Maple Ave., Pimlico, Baltimore, Md.

BOSTON

Meets at American House, Boston, Mass. First Thursday each month. Secretary Thos. Johnson, 41 first St., South Boston, Mass.

BRIDGEPORT

Meets first and third Friday of each month at Chamber of Commerce Rooms, Stratfield Hotel. Secretary, Wm. Ehrencrona, Box 301, R. F. D. No. 1., Bridgeport, Conn.

CHICAGO

Meets second Saturday of each month, at 8 p. m., Atlantic Hotel, 316 S. Clark St. Secretary, J. C. Kretschmer, 1914 Warner Ave.

CINCINNATI

Meets every Thursday, 7:30 p. m., at Vocational Training School, Spring and Liberty St. Secretary, Al. Yeager, 2021 Sherman Ave., Norwood, Ohio.

CLEVELAND

Meets first Saturday of each month at Hotel Winton. H. Terdoest, 380 Pioneer Ave., Akron, Ohio.

HARTFORD-CONN. VALLEY

Meets fourth Monday in each month alternately at 266 Pearl St., Hartford, Conn., and corner Broadway and Worthington St., Springfield. Secretary, Vernon Grant, 43 Putnam St., Bristol, Conn.

DAYTON

Meets first Saturday of each month at the Y. M. C. A., Dayton, Ohio. Secretary, Robert G. Suman, 2734 Ridge Road, Dayton, Ohio.

DETROIT

Meets the first Friday of each month at the Hotel Statler, Louis II Room, Detroit. Secretary, Chas. Phillips, 13421 Camden Ave., Detroit, Mich.

GRAND RAPIDS

Meets on the second Friday of each month at 528 Lake Michigan Drive, N. W. Secretary, Jacob Van Dyke, 1361 Union Ave., N. E., Grand Rapids, Mich.

INDIANAPOLIS

Meets the second Saturday of each month at Hotel Denison. Secretary, Louis Mertz, 1725 Union St., Indianapolis, Ind.

LOS ANGELES

Meets second Wednesday of each month at the Elite, 633 E. Flower St., Los Angeles, Calif. Secretary, M. D. Rynkofs, 1354 W. 25th St., Los Angeles, Calif.

MILWAUKEE

Meets second and fourth Thursdays of each month at Cor. 3rd St. and Highland Ave. J. N. Hock, 1229 W. 24th St., Milwaukee, Wis.

MONTREAL

Meets last Friday of month at Office of Secretary, John H. Feelay, 411 Aylmer St., Montreal, Quebec, Canada.

NEWARK

Meets first and third Fridays of each month at Franklin Hall, 41 Franklin St., Newark, N. J., at 8 p. m. Secretary-Treasurer, Geo. Rueter, P. O. Box 201, Newark, N. J.

NEW YORK

Meets every second and fourth Fridays of each month in the World Building, Park Row, New York City, N. Y. Secretary-Treasurer, J. E. Sterling, 2581 46th St., Astoria, L. I.

PHILADELPHIA

Meets first Friday of each month in the Harrison Laboratory Building, University of Pennsylvania, 34th and Spruce Sts. Secretary, P. Uhl, 2432 North 29th St., Philadelphia, Pa.

PITTSBURGH

Meets first Friday of each month at 8 p. m., at downtown branch, Y. M. C. A. Secretary, S. E. Hedden, 227 Fifth St., Aspinwall, Pa.

PROVIDENCE-ATTLEBORO

Meets first and third Thursday of each month at 44 Washington St., Prov. Engineers Rooms, Providence, R. I. Secretary, J. H. Andrews, 19 Rosedale St., Providence, R. I.

ROCHESTER

Meets every third Friday of each month at the Powers Hotel. Secretary, Chas. Griffin, 24 Garson Ave., Rochester, N. Y.

ST. LOUIS

Meets second Friday of each month at Central Y. M. C. A., 16th and Locust St. Secretary, C. T. McGinley, 8214 Fairham Ave., University City, Mo.

TOLEDO

Meets first Thursday of each month at Toledo Secor Hotel, corner Cherry and Page Sts. Secretary, L. D. Cope, 3747 Grantley Rd., Toledo, O.

TORONTO

Meets fourth Monday of each month at Canadian Foresters' Hall, 22 College St., Room No. 2. Secretary, H. W. Graham, 102 Robina Ave., Toronto, Canada.

WATERBURY

Meets the second Friday of the month at Engineers Hall, No. 11 East Main Street. Wm. F. Guilfoile, secretary, P. O. Box 961, Waterbury, Conn.

WORCESTER

Meets Directors' Room, Chamber of Commerce, Worcester, Mass. Roger H. Bryant, Secretary, 94 Grove St., Worcester, Mass.